VERTICAL FARMING:
A FUTURISTIC CONCEPT IN SUSTAINABLE URBAN ECOSYSTEMS CREATING POTENTIAL OPPORTUNITIES

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INTRODUCTION

Due to industrial development and urbanization, we are losing arable lands every day. By 2050, the world's population is expected to grow to 9.7 billion people, and feeding it will be a huge challenge. Increasing food demand due to a growing population along with ever decreasing arable lands, scarcity in water resources, climate change and heavy degradation of the soil possess the greatest challenges being faced by us. Many believe that vertical farming can be the answer to this challenge. Do vertical farming can be the solution to this problem? Let us discuss!

In 1915, Gilbert Ellis Bailey coined the term "Vertical farming" and wrote a book titled "Vertical Farming". In the early 1930s, William Frederick Gerick pioneered hydroponics at the University of California at Berkley. In the 1980s, Ake Olsson a Swedish ecological farmers, invented a spiral-shaped rail system for growing plants and suggested vertical farming as a means for producing vegetables in cities. His concept was to grow the food in urban areas itself utilizing less distance and saving the time in bringing the food produced in rural areas to the cities.

WHAT IS VERTICAL FARMING?

Vertical farming could enable food production in an efficient and sustainable manner, save water and energy, enhance the economy, reduce pollution, provide new employment opportunities, restore ecosystems, and provide access to healthy food. In a controlled environment, crops will be less subject to the infestation, the nutrient cycle, crop rotation, polluted water runoff, pesticides and dust.

Vertical farms also utilize advanced technologies and intensive farming methods that can exponentially increase production. Researchers have been optimizing indoor farming by calibrating, tuning and adjusting a wide-range of variables including light intensity, light colour, space temperature, crop and root, CO_2 contents, soil, water, and air humidity. In addition, vertical farming provides an opportunity to support the local economy. Abandoned urban buildings, other structures like a skyscraper, shipping container or repurposed warehouse can be converted into vertical farms to provide healthy food in neighbourhoods where fresh produce is scarce. Using Controlled Environment Agriculture (CEA) technology, this modern idea uses indoor farming techniques. The artificial control of temperature, light, humidity, and gases makes producing foods and medicine indoor possible. In many ways, vertical farming is similar to greenhouses where metal reflectors and artificial lighting augment natural sunlight. The primary goal of vertical farming is maximizing crops output in a limited space.

WHY VERTICAL FARMING?

- Vertical Farming holds the promise of addressing environmental issues by enabling more food to be produced with less resources use.
- Minimization of water requirements (through water recycling).
- Steady supply of the products to the centres of demand, bringing down the necessity for storing and refrigeration.
- Food, nutrition insecurity and poverty are major phenomenon in urban centres which particularly affect the urban poor and unemployed youth.

HOW VERTICAL FARMING WORKS

There are four critical areas in understanding how vertical farming works:

1. Physical layout- The primary goal of vertical farming is producing more foods per square meter. To accomplish this goal, crops are cultivated in stacked layers in a tower life structure.
2. Lighting- a perfect combination of natural and artificial lights is used to maintain the perfect light level in the room. Technologies such as rotating beds are used to improve lighting efficiency.
3. Growing medium- Instead of soil, aeroponic, aquaponics or hydroponic growing mediums are used. Peat moss or coconut husks and similar non-soil mediums are very common in vertical farming.
4. Sustainability features- The vertical farming method uses various sustainability features to offset the energy cost of farming. In fact, vertical farming uses 95% less water.

GENERAL STRUCTURE OF VERTICAL FARMING

The vertical farm is planned to be totally using artificial light or both artificial and natural light should be taken into account. There are two options available LED (light emitting diode) or HPS (high-pressure sodium) When choosing the crops to grow considering which plants can be better bred indoors. Because of limitations imposed by height, plants that grow on trees such as bananas, olives, avocados, and nuts are hard to grow inside. Most common products now produced in vertical farms are lettuce, tomato, chinese cabbage, eggplant, green onion/chives, kale spinach and cucumber.

SYSTEMS OF VERTICAL FARMING

1. Hydroponics

"Hydroponics" is the growing of plants in a liquid nutrient solution with or without the use of artificial media. Commonly used mediums include expanded clay, coir, perlite, vermiculite, brick shards, polystyrene packing peanuts and wood fibre. Hydroponics has been recognized as a viable method of producing vegetables (tomatoes, lettuce, cucumbers and peppers) as well as ornamental crops such as herbs, roses, freesia and foliage plants.

The predominant growing system used in vertical farms, hydroponics involves growing plants in nutrient solutions that are free of soil. The plant roots are submerged in the nutrient solution, which is frequently monitored and circulated for maintaining correct chemical composition. This method results in more uniform and better yields the optimum combination of nutrients can be provided to all plants. It also provides less labour intensive way to manage larger areas of production. It is a cleaner process that no animal excreta are used. Easier way to control nutrient level and pH balance. In 1950 commercial farms are started at America, Europe, Asia, Africa, Japan most successfully practiced in Israel.

2. Aeroponics

The Aeroponic System is probably the most high-tech type of hydroponic gardening. A timer controls the nutrient pump. The aeroponic system needs a short cycle timer that runs the pump for a few seconds every couple of minutes. In aeroponics, there is no growing medium and hence, no containers for growing crops. In this system, mist or nutrient solutions are used instead of water. As the plants are tied to a support and roots are sprayed with nutrient solution, it requires very less space, very less water and no soil.

ADVANTAGES OF VERTICAL FARMING

- It offers a plan to handle future food demands by producing extremely high yields per available land or area.
- It allows crops to grow year-round without the risk natural uncertainties like floods, uneven rains, hail and snowfall, drought, dry spells, temperature extremities, epidemics of pest and diseases, etc.
- It significantly uses 70 to 95% less water
- Pesticide free or organic food is produced as there is no use of pesticides.
- It reduces the cost over transporting loads of food grains from rural area to urban areas and reduce the spoilage occurring there in. Fossil fuel consumption in transporting the farm produce to cities from village places is also reduced to a greater extent.

DISADVANTAGES

- Huge initial for establishing the vertical farming system is the major constraint.
- Pollination would be very difficult and costly
- It would involve higher labor costs
- It relies too much on technology and one day of power loss would be devastating
- Huge energy cost as growing plant is entirely with artificial lights. The excess nutrients used in vertical farming may interfere and contaminate the main urban water system

FEASIBILITY OF VERTICAL FARMING IN INDIA

India is one of the largest producer of vegetables, fruits and many other agricultural commodities. In India, vertical farming has been introduced. ICAR experts are working on the concept of 'vertical farming' in soil-less conditions, in which food crops can be grown even on multi-storeyed buildings in metros like New Delhi, Mumbai, Kolkata and Chennai without using soil or pesticides. Scientists in at the Bidhan Chandra Krishi Viswa Vidyalaya Nadia have already had initial success in working on a small scale on brinjal and tomato, but implementing it on a large scale would require additional fund. Productive efficiency of vertical farming was tested in Punjab where scientist have attained initial success in growing potato tuber, fruit and vegetables in soil less and controlled environment.

CONCLUSION

It is the practice of producing food and medicine in vertically stacked layers, vertically inclined surfaces and/or integrated in other structures. The land productivity of Vertical Farming is twice as high as traditional agriculture. Yields are approximately 20 times higher. It can produce crops year-round. Less spoilage, infestation, and energy required than conventional farming encounters. Mostly independent of weather and protected from extreme weather events.
Reduces transportation distance, thereby reducing cost, energy and carbon footprint. Higher quality produce with greater nutritional value and a longer shelf life. No need for the use of harmful herbicides or pesticides. Conservation of resources. Applicable on non-arable lands. Requires only 8% of the normal water consumption. Minimizes the negative environmental effects of agriculture. Operating and capital cost savings over field agriculture. High levels of food safety.